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ABSTRACT

Whether IQ is or is not related to reading depends on such variables as the difficulty of the task, the time allowed for learning, the quality of instruction, and the nature of the tests used for assessing intelligence and reading. The relationship between intelligence--as assessed by an individual measuring instrument, such as the Stanford-Binet--and reading is at least minimized if the difficulty of the task is within the capabilities of the learner, individual differences in rate of learning are taken into account, instruction is organized to facilitate sequential learning, directions are given clearly so that all students understand them, and assessment of progress is based on criterion-referenced tests. On the other hand, if all of these variables are at the other extremes of their continua, and particularly if group tests of intelligence and criterion-referenced tests of reading achievement are used, then the relationship between intelligence and reading tends to be maximized. (Author)

IQ IS AND IS NOT RELATED TO READING

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Invitational paper read at the Annual Convention of the International Reading Association, Denver, Colorado, May 6, 1973

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My apparently paradoxical title emphasizes the variable relationship between IQ and reading. The explanation for this variable relationship is that if a particular reading task, such as acquisition of symbol-sound correspondence is within the mental age range of a group of students and instructional conditions allow adequate time for achieving the task, then IQ may have a significant relationship to rate of acquisition, but not to accomplishment of the task. However, if the reading task challenges even the most capable students in the class and time or trials for learning the task is limited, then IQ is likely to be highly correlated with achievement of the task.

This explanation is consistent with the generalization formulated by Cook (1951), following his review of research literature on learning and individual differences. Although acknowledging difficulties in measurement (Anastasi, 1934), Cook, nevertheless concluded:

> ... if the responses to be learned are sufficiently simple and the goals that have been set so limited that a high proportion of the group can master them during the period of learning, the variability of the group becomes less; if the task is complex and the goals unlimited, so that the abilities of the

most apt members of the group are taxed during the period of learning, the variability of the group increases.

Simple tasks are those in which the variability of a group decreases as a function of practice. Complex tasks are those in which the variability of a group increases as a result of instructions and cannot be mastered by the group, regardless of the time devoted to them (Peterson and Barlow, 1928; Bloom, 1971; Cronbach, 1971).

Simple and complex tasks in reading exhibit these variabilities. For example, variability in acquisition of word recognition abilities, such as symbol-sound correspondence decreases at successively higher grade levels, while the range in achievement in word meaning increases throughout the grades. So does the range in mental age and the variability in the IQ's of bright vs. average vs. dull (Cook, 1951; Bayley, 1949, 1955). Hence for members of a particular group the correlations between IQ and word recognition abilities such as symbol-sound correspondence decreases while the correlation between IQ and reading comprehension increases.

Thus, the paradoxical relationship between IQ and reading hinges on the nature of the reading task, the developmental stage of the reader, and differential changes during the acquisition stage in the variability of components defined as reading. The term "reading" is, in fact, used ambiguously to refer to reading acquisition or to reading comprehension. The ambiguity is further compounded when the developmental stage of the reader, which can vary from beginning to skilled reading, is unspecified (Wiener and Cromer, 1967). Beginning readers, still in the process of acquiring implicit rules for relating orthographic symbols to linguistic forms

(Reed, 1965) are quite variable in this process of reading. Hence, the relationship between IQ and these components of reading would still be high at this stage of their reading development.

However, skilled readers are not only less variable in word recognition abilities, such as symbol to sound relationships, but they also seem to have short-circuited them. Instead, they engage in "lexical reading," which tends to bypass phonological processes and involves a more direct correspondence between graphemic cues and lexical meanings (C. Chomsky, 1970). At this stage of reading development, individuals may perceive words as though they were ideographs (Smith, 1972). Apparently, in the highly skilled reader, lexical meanings are anticipated, triggered, and confirmed by perceptual sampling of graphemic cues (Hochberg and Brooks, 1970). For skilled readers, then, there would be little or no variability in accuracy in word recognition ability. Hence, the correlation between their IQ and reading acquisition behavior would be zero.

We can demonstrate these changes in variability and resulting changes in their correlations with IQ for members of a particular age group. For example, as shown in Figure 1, if we administer equivalent forms of the same norm-referenced reading achievement test given at

Insert Figure 1 About Here

the end of grades one, two and three to each successive grade level, the correlation between IQ and performance on this test will steadily drop as the group progresses through the grades. The reason for this decreasing trend is that we will have kept the reading task constant while members of the group were learning to read and developing in

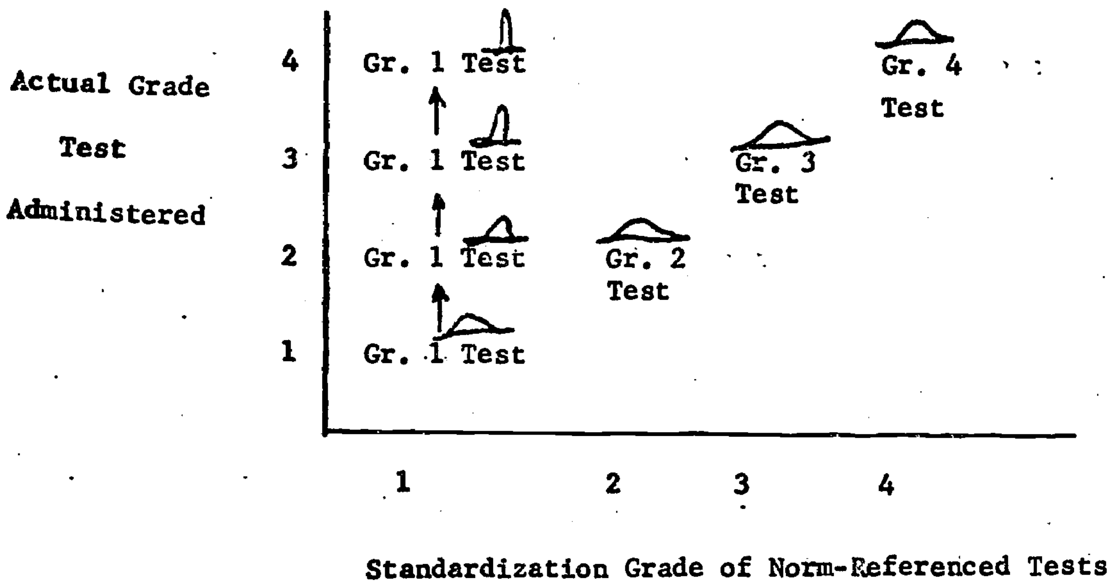

Figure 1. Schematic design to show norm-referenced tests for assessing reading acquisition and norm-referenced reading achievment. The diagram shows that the Grade 1 test is also used in Grades 2, 3 and 4 as a type of criterion referenced test. The first column shows the Grade 1 test administered at the end Grades 1, 2, 3, and 4 for those students who have not yet mastered the test. The diagonal norm-referenced tests are administered as usual at the end of Grades 1, 2, 3 and 4 to all children in these grades.

The column 1 norm-referenced test administered in Grade 1 can also be given as a criterion-referenced test to assess reading acquisition over Grades 1, 2, 3, and 4. The diagonal tests provide the usual norm-referenced test information on relative reading achievement. Under these test conditions, correlations between IQ and criterion-referenced tests over Grades 1-4 (Column 1) decrease and between IQ and norm-referenced tests over Grades 1-4 (Diagonal) increase.

The shape of the distributions above each test indicates that the variability of the group decreases at successive grade levels for the Grade 1 test used as a criterion-referenced test, but the variability of the group is maintained by the usual norm-referenced tests given the end of each grade.

abilities requisite to performance on the reading test. As they did so, their mean performance on the test would gradually approach the top score and their variability on the test would be reduced. In short, they would tend to have learned to read and would therefore have mastered the test. As they did so, the correlation between performance on this test of reading acquisition and performance on the IQ test would decrease.

This use of the norm-referenced grade one reading tests contrasts with the usual way in which tests are constructed and administered. Norm-referenced tests are designed so that the average individual at each grade level gets only fifty percent of the items correct on the test. This test construction objective is obtained in reading tests by using more difficult words and longer, more complex sentences on successive grade level tests. Thus, the typical, norm-referenced test administered in the elementary grades assesses not only development of reading acquisition behavior but also achievement in knowledge of morphemes, vocabulary, and other cognitive abilities tapped by the longer and more complex sentences. Essentially, the norm-referenced test increases in difficulty because it gradually shifts from measurement of reading acquisition behavior to measurement of cognitive and lexical development, the very same tasks usually included in tests of intelligence. Under these test conditions, the correlation between IQ and reading, of course, remains at a high level for members of a group, even though they had learned to read, ~~and~~ the teacher then has only one test score which cannot be separated into reading acquisition behavior and general reading achievement.

The remedy is quite clear: separate the definitions and assessment of reading acquisition behavior from reading achievement. One way this separation can be achieved is by administering in grades one, two, three and perhaps four, either the same or equivalent forms of the same standardized, norm referenced test that is usually given only at the end of grade one. This annual, repeated testing would, of course, only be administered to those students who have not yet mastered the test. Used this way, the norm-referenced test would act like a criterion-referenced test because all the components of the test would be kept constant while students were learning to read and improving in reading achievement. Keeping the task constant is a necessary condition for assessing any kind of learning. Thus, progress in learning to read could be readily measured and separated in the primary grades from general reading achievement.

Reading achievement, as traditionally measured by norm-referenced tests, can co-occur with assessment of reading acquisition behavior at grades two and above by administering the usual norm-referenced tests given at these grade levels. From these two types of assessment, teachers would then gain diagnostic information on an individual's progress in learning to read in relation to first grade norms and his general reading ability in relation to his grade level or peer group.[1]

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[1]Norm-referenced tests given at the ends of grades 2, 3 and 4 and higher grade levels can also be repeated at successive grade levels to measure reading acquisition behavior on more complex words and sentences.

Although my paradoxical title has now been explained, further clarification and particularly evidence to support my position still needs to be adduced. For this purpose, I shall briefly review the nature and development of both reading and IQ, then draw upon theoretical and empirical evidence on conditions of schooling and instruction which influence the relationship between IQ and reading.

Nature and Development of Reading

An individual formally starts to learn to read when he is at a stage where he can mobilize almost fully developed linguistic abilities (Ruddell, 1970; Singer, 1972). As early as the first grade level, he can utilize his phonological, morphological, syntactic and lexical abilities for responding to print. He is likely to do so, if instruction is based on connected discourse, instead of isolated letters or words. For example, an analysis of errors in oral reading of connected discourse in the first grade indicated that the errors were predictable from the syntactic and semantic constraints in the parts of the sentences preceding the error (Weber, 1970). Furthermore, Goodman (1965) has demonstrated that contextual constraints facilitate and augment accuracy in word recognition during the process of reading.

As an individual progresses in reading, he first utilizes linguistic constraints for predicting unknown graphemes. He then proceeds to a second stage where he apparently attempts to use recently acquired analytical processes for recognizing unknown, printed words. But, if his analytical processes fail, he does not use sentence context to predict the unknown word. Instead, he tends to give no response. Apparently his recently acquired emphasis on analytical techniques for recognizing printed words leads him to exceed his memory capabilities for holding preceding ideas in mind. Hence, he cannot use contextual constraints. In short, for unknown words, he acts like a word-by-word reader. With further progress and skill in word recognition processes, he proceeds to a third stage where he integrates his linguistic constraints and analytical processes for identifying printed words. Accomplishment of this integration is usually achieved by the second grade level (Biemiller, 1970), particularly if reading instruction starts out with connected discourse which capitalizes on natural language for word recognition (Barr, 1972). But, the natural language strategy,utilized in such reading programs as the language experience approach with its emphasis on whole word recognition, must soon be supplemented with more analytic processes in order to increase effectiveness and efficiency in acquisition of word recognition ability (Samuels, 1970; Williams, 1970).

Thus, beginning readers learn to mobilize and integrate linguistic and perceptual processes in responding to print. These processes can be inferred from ~~oral~~ errors in oral reading ~~responding to print~~. But, they can also be statistically determined by multiple regression analysis. Using this statistical procedure at the fourth grade level, phonological, semantic, morphological, and conceptual variables were found to account for some 90 per cent of individual differences in attainment of power of reading. A perceptual-oculomotor variable also entered into prediction of speed of reading (Gilbert, 1953; Singer, 1965, 1969). At the sixth grade level, these predictors continued to account for individual differences in achievement of speed and power of reading. Values, based on healthy resolution of conflicts (Athey, 1970; Athey and Holmes, 1969), also serve in the process of reading. They determine whether the individual is likely to mobilize the necessary systems for attempting to satisfy the demands of the reading task.

Although some abilities and processes continue to be involved in the structure and dynamics of reading, they cease to be first order, multiple-regression predictors of reading achievement when the group of readers involved in the statistical prediction samples have mastered them.

no ¶

This interpretation explains why syntactic ability does not account for individual differences at the fourth grade level. This linguistic ability, with the exception of development of some sophisticated rules and versatility in grammatical control (C. Chomsky, 1970; Loban, 1963; Strickland, 1962; Ruddell, 1970), approaches maturity at age six when children usually begin formal reading instruction. In other words, if a group is <u>alike</u> in a certain function that underlies general reading ability, such as syntactic ability, that function does not account for individual differences in reading achievement at the first level of prediction. Or, when a group of readers becomes alike in a certain function, such as letter-name knowledge or letter-sound relationships, which are predictors of reading achievement in grade one (Murphy and Durrell, 1964), these functions, although still mobilizable in the reading process, do not remain as first order predictors of general reading ability at subsequent grade levels.

Soon after the sixth grade level, word recognition and perceptual oculomotor control tend to drop out as first level predictors because about this time individuals, in general, tend to approach maturity in most word recognition processes and in perceptual-oculomotor control (Gilbert, 1953). But, at the sixth grade, individuals tend to increase their vocabulary ability, and more so from their reading than from their listening (Armstrong, 1953) because the vocabulary of literature has a greater range and depth than the vocabulary used for general, oral discourse. Hence, unlike word recognition processes, vocabulary ability continues to develop and remains as a predictor throughout the grades and at the college level (Holmes, 1954; Singer 1965).

In general, ~~Thus~~, the process of reading draws upon visual, perceptual, linguistic and other cognitive processes plus certain values and personality components. But, as individuals mature in the process of reading, individual differences in general reading ability shift from word recognition to semantic and morphological predictors. As a variable, such as word recognition, no longer accounts for individual differences in reading achievement, its relationship with IQ concomitantly diminishes for a particular age group. But if a predictor, such as vocabulary, becomes more variable for a particular group, then its relationship with IQ increases. Thus, the relationship between IQ and components of reading change over the developmental span.

Nature and Development of IQ

IQ, operationally defined by the Stanford Binet test of intelligence, is the ratio of mental age to chronological age multiplied by 100.[1] Mental age refers to the difficulty level of tasks that an individual can accomplish. Higher mental ages reflect ability to accomplish more verbally and more quantitatively abstract tasks. IQ has traditionally been defined as rate of learning or rate of past achievement (Smith and Dechant, 1961; Weit, 1967), but, recently, IQ has been redefined as "developmental rate, the time required to arrive at a particular mental age." Developmental rate is then distinguished from "learning rate, the rate at which new information is acquired." Jensen and Rohwer (1968) arrived at these distinctions by showing that even though familial retardates of IQ 58 had been matched with normals of IQ 105 on mental age of nine years, the normals had rates on serial and paired associate learning on the average about three to four times faster than the mentally retarded adults. Jensen had previously found that in groups of retarded, average and gifted who were equally homogeneous in IQ <u>and</u> MA, the retardates had greater heterogeneity of learning rates than the normals. In other words, learning rate is a function of both MA <u>and</u> IQ. That is, level of difficulty of tasks achieved and past rate of development are good predictors of difficulty

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[1] As the Wechsler-Bellevue has done from its inception, the Stanford-Binet Intelligence Scale in its 1960 revision adopted the concept of the deviation IQ. Based on a mean of 100 and a standard deviation of 16, for each group, deviation IQ's are comparable throughout the age range of the scale, unlike IQ's computed from mental age which vary in means and standard deviations from one age group to another.

of tasks that can be attained and of rate of learning, provided conditions of instruction remain unchanged.

However, given adequate time for learning, such as relating letters to sound, individuals within the normal range of intelligence can still master tasks which are within their mental age levels, albeit at variable rates.

As used here, the <u>normal range of intelligence</u> is a continuum which excludes only organic retardates, those who have known organic defects (Zigler, 1967). In general, ~~In other words~~, if an individual is in the normal range of intelligence, he should be able to master the reading acquisition task, if it does not exceed his mental age and if he is given sufficient time for learning it.

More specifically, the normal range of intelligence begins to overlap ... as shown in Figure 2.

Like other facets of an individual's development, mental functions, as assessed by the Stanford-Binet, also vary in time of <u>initial manifestation</u> and <u>rate of development</u> (Bayley, 1949, 1955). These latencies and asynchronies in the development of mental functions explain why the correlations in intelligence from preschool to adolescence are relatively low over the long time interval, but increase as the interval between ages of testing decrease. For example, as shown in Figure ~~2~~ 3, over a six year range in prediction, for an age

---------------Insert Figure ~~2~~ 3 About Here-------------------------

interval from 2 to 8, the correlation is .43, but from 4 to 10 it increases to .66, while from 6 to 12 it is even higher, .74, and from 8 to 14 it is .85 (Honzik et al., 1948). In general, the higher the age and the lower the interval between initial assessment and terminal

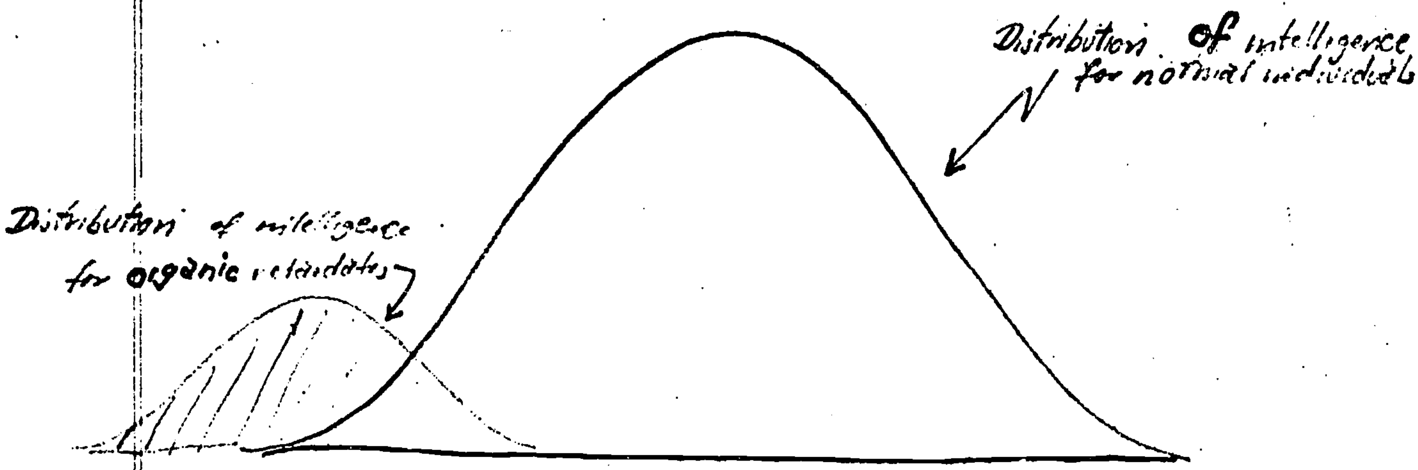

Figure 2. The distribution of intelligence for normal individuals and organic retardates (after Zigler, 1967)

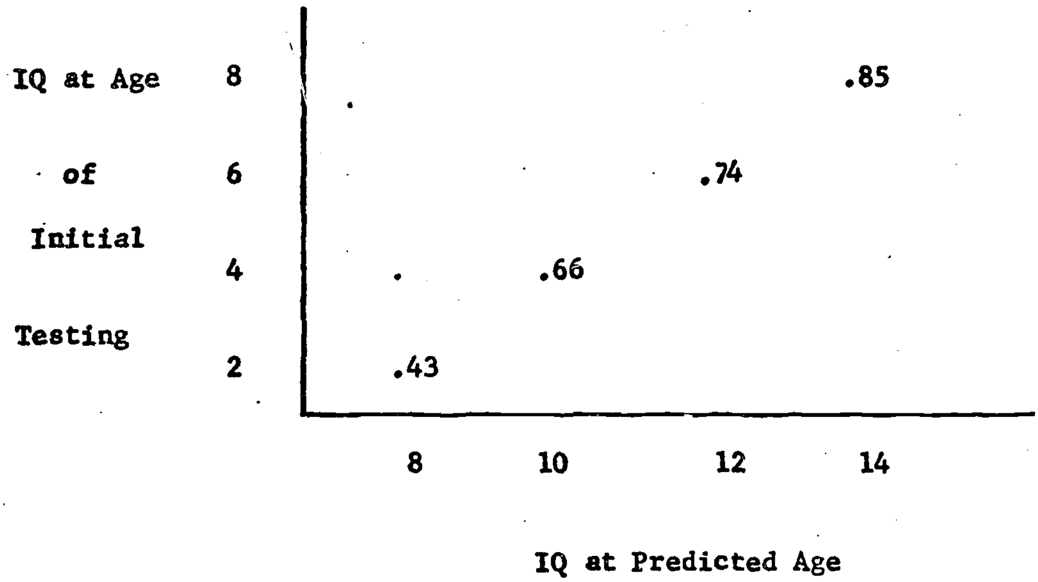

Figure ~~2~~ 3. Correlations between IQ at six year intervals (after Honzik et al., 1948).

prediction, the more likely the same functions are being correlated and hence the higher is the correlation. Since symbolic functions begin to be assessed about age four and since these functions increasingly enter into intelligence testing, correlations in IQ become increasingly higher and more stable at the older age intervals (Bloom, 1971).

However, changes in level of intellectual ability do occur. Over 50 per cent of a group of individuals initially assessed at age six had changed by 15 or more IQ points and one third of the group had changed over 20 IQ points by age 18 (Honzik, et al., 1948). These magnitudes in IQ changes mean that individuals involved in this change would be reclassified over the twelve year span from "dull" to "average" or from "average" to "bright" or vice-versa.

Because of these changes in IQ, caution must be exercised in making predictions of intellectual performance, particularly over a long time interval. Consequently, use of intellectual ability as a criterion for reading expectancy would also have to be modified. For example, the following principle for estimating expected level of reading achievement from a level of intellectual ability would have to be modified to take into account not only variation in performance due to socioeconomic and ethnic status as Harris (1972, p. 43) recently did in stating the principle, but also (a) the time gap between assessment of intelligence and measurement of reading achievement, and (b) the criterion of intelligence used for estimating reading expectancy. The words in italics are mine:

> A verbal intelligence scale, such as the Revised Stanford-Binet or the Wechsler Verbal I.Q., is still

> the best basis for estimating the level at which a child should be able to read with comprehnsion, provided the assessment of intelligence occurs about the same time as the estimate of individual's reading level and the criterion used for estimating expected reading achievement is mental age.

Note that in this expectancy formula Harris is careful to point out that he is estimating reading with comprehension, not just reading acquisition behavior. He is therefore including both reading acquisition behavior and general reading achievement in his estimation of expected level of reading achievement. If reading acquisition behavior alone were being estimated, then the IQ and the mental age criterion would have diminishing utility as expectancy criteria as members of a group progress through school and learned to read.

Thus, throughout the normal range of intelligence, the correlation between IQ or between mental age and reading should decrease as members of the group learn to read.

However, even though IQ may have some relation with reading acquisition behavior, it should be made explicit that IQ alone does not provide any useful information about reading achievement. For example, if you only knew that one individual had an IQ of 150 and other an IQ of 90, you would still not be able to make any valid statement about their reading ability. Only if you made an assumption about their chronological ages could you arrive at any valid estimate of their reading ability. In other words, it is necessary to know not only IQ but also chronological age so that mental age can be computed in estimating reading potential.

Usually teachers have a particular age group in mind when they correlate IQ with reading achievement. Implicitly then, they are also taking into account mental age and years of instruction in reading. Consequently, for predicting reading expectancy, teachers tend to operate on both IQ and MA, as recently advocated by Jensen and Rohwer (1968). Approaching more closely what teachers tend to do, Bond and Tinker (1967) some time ago arrived at the following expectancy formula:

$$\text{Expected Reading Grade} = \text{Years in School} \times \text{IQ} + 1.0$$

The implicit use of MA and years of schooling when correlating IQ with reading achievement is reflected throughout this paper in the use of the phrase "IQ for members of a particular age group" or its abbreviated version, "IQ for members of a group."

Although IQ may continue to be related to facilitation and application of learning, IQ for members of a group is not a general index of learning ability (Woodrow, 1949; Stake, 196~~0~~1), nor is it highly correlated with specific types of laboratory learning, such as verbal paired-associate type learning which is a type of learning that is involved in reading acquisition behavior. However, efficiency and proficiency in learning to read is, also, in part, a function of the conditions of instruction.

IQ in Relation to Verbal Learning

Evidently, paired associate learning is related to school achievement, particularly when the paired associate tasks involve verbal content (Duncanson, 1964; Rohwer, 1970) or abstract words (Stevenson, et al., 1968). More germane, the paired-associates paradigm has been successfully used in teaching some of the word recognition skills involved in the initial stages of learning to read (Gibson, 1965; Samuel, 1970; Williams, 1970; Singer, 1971).

Although verbal learning correlates well with verbal achievement, its relationship with IQ varies. The variability is to some degree attributable to conditions of instruction.

Under some conditions, the relationship between IQ and various types of learning, including paired-associate learning is low. For example, Stevenson et al. (1968) administered paired-associate, discrimination, probability, and incidental learning tasks to bright, average and dull seventh graders. There were more significant correlations between IQ and learning these tasks for average than for bright or dull students. These data suggested to the investigators that the within groups differences for the bright and dull, particularly the boys, was strongly influenced by factors other than intelligence.

Furthermore, when retarded children from this study were compared with their mental age peers, their rates of learning on paired associate tasks, as indicated by number of correct responses, was "similar", but on problem solving the bright students were superior. The investigators concluded that the deficiencies of familial mentally retarded students are more in application of previous knowledge than in acquisition of new information, particularly when tasks are highly structured and immediate feedback is provided on each response.

Conflicting evidence on the hypothesis of equivalent rate of learning and retention of normal and mentally retarded children can often be attributed to methodological differences in matching, materials, and methods, but Vergason's study appears to be free of these pitfalls (Prehm, 1966).

Vergason (1968) found that normal children were superior for one day retention on paired associates taken from the Peabody Picture Vocabulary Test. But, after a 30 day interval, the normal children were significantly higher to the retarded on the minimum learning but not on the overlearning tasks. The interpretation of the difference, based on observation of children in the experimental situation, was that normal children engaged in rehearsal while retarded children did not. The implication from Vergason's study for reading instruction is that while retarded children may learn at a rate equal to normal children, more overlearning is necessary for retarded children in order for them to attain equal retention. Gates (1930) also reported that in learning to read, slow learners in comparison with fast learners needed many more repetitions of a word in context before the slow learner could recognize the word accurately. We hasten to point out that learning to recognize whole words quickly and accurately in a traditional basal reader program is usually necessary for cumulative positive progress. If a slow learner does not get the necessary repetitions, but is still promoted in reading, then he might suffer from cumulative negative progress.

Whether paired-associates learning is significantly related to IQ or not depends somewhat on the novelty of the task. McCullers (1965) assigned fourth, fifth, and sixth graders at random to learning six words which varied from "weak" to "strong" association, such as "little-small" vs. "little-thin". He found that the Lorge-Thorndike IQ and the Iowa Test of Basic Skills correlated only .19 and .06 for the strongly associated pairs and -.44 and -.53, respectively, for the weakly associated pairs. Again, the implication from this study and from Vergason's is that when the difficulty or novelty of the material increases, children with lower IQ's will not only need more trials to learn it but they will also need to overlearn it in order to remain on an equal cumulative learning level with their brighter peers.

The type of stimulus task also affects the relation between IQ and paired-associate learning. Rohwer (1970) investigated the effects of presenting verbal pairs under conditions of increasing "mental elaboration". His procedure consisted of relating the pairs by temporal contiguity only, by a conjunction or preposition, by a verb in a sentence context, and by presenting these elaborations with or without acting them out. Rohwers' and others' results (Martin, 1967; Milgrim, 1967) indicated that when only the retardates were provided with mental elaboration in the paired-associates task, their performance equalled that of normals. When both retarded and normal children were provided with sentence elaboration, the performance of both groups improved significantly. In general, the type of elaboration used resulted in similar paired-associate performance patterns for retarded and normal children. Rohwer inferred from these results that both groups had "comparable cognitive structures", but comparability in cognitive structure did not imply equivalence in learning proficiency.

In general, the correlations reported by Rohwer for IQ and paired-associates learning averaged only about .32. He concluded that there is a "relatively strong" possibility that verbal elaboration activities account for "individual variance shared between IQ and paired-associate learning".

If so, then the implication from Rohwer's work is that presenting words to be recognized and ideas to be associated in meaningful sentence context enhances learning efficiency and proficiency. However, normals may provide their own mental elaboration when necessary, while mentally retarded do not tend to do so. For example, if a teacher presents a letter or a sound in isolation, the normal or bright child is more likely to put the letter or sound in context. Thus, given the letter, "a", he might add, "as in cat," which elaborates and facilitates his acquisition of a symbol-sound relationship. The mentally retarded child's learning of this relationship is likely to be as efficient, but he needs the teacher to supply the context. In both cases, the sentence would enable the readers to use their conceptual and linguistic processes and abilities to facilitate organization, storage, and retrieval of information.

However, in the beginning stages of learning to read, use of pictures or sentence context may also initially divert attention from target or novel words rather than facilitate acquisition of correct responses to verbal stimuli (Samuels, 1967; Singer, Samuels, and Spiroff, 1973). Perhaps the issue may be resolved by the hypothesis that in the process of reading, sentence context facilitates correct anticipation of associated words; but focal attention upon the particular words is necessary for identification of these words in isolation.

Evidence on the relationship between IQ and learning has been summarized by Zeaman and House (1967). They concluded that when IQ differences are as large as 40 points or more, then IQ is clearly related to verbal learning. But, when the performance of normals and retardates is reduced because of restrictions in range of variation in verbal learning performance or because of sampling selection procedures or use of relatively easy tasks, IQ is not related to learning tasks.

However, an IQ difference of 40 or more points gets the mentally retarded sample down to an IQ of 60 or less. At this level, even though the group may be defined as familial retardates, the likelihood of getting out of the normal range of intelligence and into the organic retardates distribution, as defined by Zigler (1967), increases. For example, Jensen, whose work is cited by Zeaman and House (1967) as showing a positive relation between IQ and verbal learning, did use an institutionalized "familial" retarded sample about IQ 55.

To explain the difference between bright and dull children's performance on learning tasks, Zeaman and House (1967) used a mathematical model based on the concept of "attention". They observed that in discrimination learning the length of the plateau before improvement begins is longer for the dull than for the bright subjects, but when learning begins, the rate is the same for both groups. The implication for instruction from this attentional theory is that teachers may be able to accelerate the onset of learning by giving directions which stress and draw the learner's attention to the relevant attributes of the task.

Thus, under appropriate conditions of instruction, IQ can have a low relationship with verbal paired-associated learning. Since this type of learning can be used for teaching reading acquisition behavior, then by analogy individuals throughout the normal range of intelligence can learn to read. More direct evidence on the decreasing relationship between IQ and reading acquisition behavior can be gleaned from classroom studies of the relation between IQ and reading.

Relation Between IQ and Reading

Even preschool children who vary throughout the normal range of intelligence can learn to read some printed words. However, in the initial stage of acquiring a reading acquisition subskill, a positive relationship is found between IQ and the subskill because there is considerable variability in the subskill prior to mastery of it by the group. In effect then, the objective for the limited time period acts as though it were open-ended or a general achievement in learning to read. For example, controlling for mental age, but allowing chronological age and IQ to vary, Davidson (1931) matched on mental age 4 years, thirteen bright, average, and dull children whose chronological ages were 3, 4, and 5 years, respectively. The question was whether these groups could learn to read equally well under the same conditions. After 10 minutes of instruction each day for 4 1/2 months, the range in success in reading was 20 to 269 words. Under this time restriction Davidson found that the brighter three year olds were superior in achievement to the older, duller children.

In Davidson's study IQ was related to number of words learned because time was held constant for all the age groups. Hence, the apparently faster rate of learning of the brighter children resulted in the greater degree of achievement. Nevertheless, all of Davidson's children, regardless of IQ or mental age, did learn to respond to printed words with some degree of success.

The relationship between IQ and reading achievement, as assessed by standardized, norm-referenced tests, as we would expect, increases with grade in school. Durkin (1966) reported that the 49 children whose mean grade-equivalent reading achievement was 2.3 at the beginning of first grade ranged in Stanford-Binet IQ from 91 to 161 with a median of 121. At the first grade level IQ correlated only .40 with reading achievement, but in successive grades the correlation increased and reached a magnitude of .79 at grade 5. An interpretation of this change from 16 to 64 percent common variance between IQ and reading achievement is that as reading achievement shifts from predominant emphasis on word recognition to stress on word meaning and comprehension, the mental functions being assessed by intelligence and reading tests have more in common. But, the low correlation at grade one also suggests that the one-to-one instructional conditions provided the early readers prior to grade one, plus others factors, such as motivation to learn to read and parental expectation, may have diminished the relationship between IQ and reading achievement.

Expectancies also influence teacher behavior. In general, teachers tend to normalize instruction (Wilson, 1963; Balow, 1964). That is, they tend to modify instruction so that they teach towards the average capability of the group. Hence the stimulation given to learners and the amount learned is related to teacher expectation of student capability, especially when the content of the curriculum is under teacher-control. At least in the initial stages of reading, teachers are able to exercise some control over which words children are expected to learn.

To test the effect of teacher expectation on adaptation of the curriculum to the capabilities of the learner, Beez (1968) randomly assigned tutors and five and six year old children to high and low expectancy conditions. The tutors were told their students were either expected to do well or poorly in school. This information then significantly influenced the number of words taught in the tutorial situation. Given 20 words to teach, the tutors in the high expectancy condition actually taught an average of 10.4 words and their students learned to recognize 5.9 words, while the tutors in the low expectancy condition taught on the average only 5.7 words and their students consequently learned to recognize only 3.7 words. There was no relationship between years of experience the tutors had in teaching and their performance in the tutorial situations nor was there any relation between student performance and their scores on the Peabody Picture Vocabulary Test. Thus, in this experiment, IQ was <u>not</u> related to number of words recognized.

Nor does performance on measures of intellectual ability alone completely predict achievement in normal classroom situations. Lambert (1970) found that paired associate learning (pairs of nouns joined by a conjunction) boosted the predicted variance in reading achievement at the end of first grade 30 percent over that accounted for by intelligence and socioeconomic status. An implication of this study, which is consistent with procedures reported in a case study (Singer and Beasley, 1970), is that school psychologists can enhance their prognosis for children's ability to learn to read by supplementing their battery of assessment devices with a rate of learning test and by putting rate of learning under student control.

Even more closely associated than mental age with reading achievement at the first grade level is *printed word perception*. That is, achievement in a specific subject or process is a better predictor of future achievement in that subject than is achievement in general. For example, Harrington and Durrell (1955) reported that visual and auditory perception of printed words had higher correlations of .64 and .56, respectively, with reading achievement at the end of grade one than did Otis mental age, which had a correlation of only .23. Also, Gates (1926) discovered that after the Stanford-Binet mental age had been partialled out from his sample of students in grades 1 to 4, the correlation of *word perception* with reading was still as high as .69, which was higher than the zero-order correlation of .50 between intelligence and reading. Furthermore, his tests of associative learning correlated only about .33 with intelligence, and even lower with reading achievement. Gates concluded:

> ...the [word] perceptive factor, irrespective of intelligence, is more closely associated with reading and spelling than all of the functions embraced in 'intelligence' as measured.

IQ for a particular group is more related to comprehension than to processes of reading. Using the matched mental age technique in which CA and IQ vary, Bliesmer (1952) compared 28 pairs of dull and bright children enrolled in public schools. The dull students were eighth and ninth graders whose Stanford Binet IQ's were 84 and below. The bright students were third and fourth graders whose IQ's were 116 and above. The mental age ranges were 10-7 to 12-6. The groups were not significantly different on reading rate, word recognition, perception of verbal relationship, meaning for details, nor on word meaning sub-tests of the Durrell Analysis of Reading Difficulty, but the bright students were significantly better on all tests of comprehension. Dunn (1954) obtained similar results. He selected 20 mentally retarded boys from special classes and matched them with 30 randomly selected boys from regular grades on Stanford-Binet mental ages. The range in mental ages was 8-0 to 10-0. His results indicated that the regular group performed significantly better on silent and oral reading and use of context clues, but not on sound-blending ability or eye-movement behavior. Templin (1954) also found low relationships at the fourth grade level between Kuhlman-Anderson mental age and phonics test: the correlations ranged from .29 for consonant sound discrimination to .43 for discrimination of sounds in words, So did Triggs (Triggs, et al 1954) who reported that in grades 4 to 6 WISC IQ correlations were .53 with comprehension, but only .15 with word recognition on the Diagnostic Survey Tests. Thus, the relationship between IQ and reading acquisition for members of a group diminishes as individuals progress towards mastery of the process of learning to read.

Methodological Considerations in Relating IQ to Reading

However, the relationship between intellectual ability and reading also varies to some degree as a function of the measures used to assess them. Correlations between IQ and word recognition subtests could remain at a high level even in grades 4, 5, and 6 if the word recognition subtests require abstraction and generalization of symbol-sound relationships or if the word recognition subtests are timed so that a premium is placed on speed of response. These conditions could account for the finding that correlation coefficients ranged from .34 to .72 between Stanford-Binet mental age and Bond silent reading tests at the fourth grade level (Reynolds, 1953).

Subtests of intelligence also differentially vary in their relationships with reading subskills and general reading ability. Consequently, inability to read may not only hamper performance on reading tests but also on the Stanford-Binet intelligence test which contains items that are identical or almost identical to reading tasks. For example, Bond and Fay (1950) found that disabled readers at the fifth grade level are handicapped by 5 to 15 points because of inability to perform on the following Stanford-Binet items: vocabulary, reading and remembering a story, abstract words, minkus completion, and dissected sentences.

Even more elements common to reading and intelligence occur when group tests of intelligence are used. Of course, the correlation between IQ and reading would be higher for these two types of tests. For example, Harootunian (1955) reported a correlation of .56 between California Achievement Tests and California Mental Maturity for seventh and eighth grades.

Other types of tests ~~of~~ intelligence vary considerably in their relationships with reading depending on the degree of commonality of tasks on the intelligence and the reading tests. Bond and Clyer (1955) reported that Primary Mental Abilities subtests of Space, Reasoning, Figure, Number, and Perception correlated only .08 to .43, while Verbal Words, Verbal Pictures, and Reasoning Words correlated .48 to .76 with Gates Test Type A (Reading to Appreciate General Significance) and D (Reading to Note Details).

In general, language functions assessed by intelligence tests are more closely related to reading than are non-language functions. Strang (1946) found that the non-language functions on the California Test of mental maturity correlated only .41 to .46, while the language functions correlated .80 to .84 with Thorndike-McCall and Gates Basic Reading Tests. Her interpretation of the results is the two types of intelligence tests tap different mental functions and these mental functions are differentially related to reading achievement. Consistent with Strang's view, Belmont and Birch (1966) concluded from an analysis of use of language, particularly from definitions given to items on the WISC vocabulary subtest, that retarded readers were characterized by "inadequacy in language functioning rather than in perceptual or manipulative skills."

Similar findings have been reported by Reed (1970, pp. 351-352) who pointed out that deficits associated with reading failure and the degree of failure are a function of the expectancy criterion used to assess capability. Employing the WISC, Gates Diagnostic Survey Test, and Iowa Silent Reading Test, plus neuropsychological tests of Tactual Performance, Reitan Color Form, Progressive Figures, and Trait-Making to 233 fifth graders, Reed demonstrated that the "patterns of deficits between expectancy and performance levels are related to the method of measurement." For example, he found that the difference between the good and poor readers on the neuropsychological subtests were lower when the groups were matched on Verbal and Performance IQ scores than when they were matched on Full Scale IQ scores. Reed warned that the percentages of poor readers in the diagnostic categories of "modality deficiencies, cognitive deficits, aptitude weaknesses, and the relation of verbal to performance abilities will vary according to method of identifying the retarded reader". He speculated that "A child's potential for reading is probably much more closely related to methods and materials used for teaching than some arbitrary index of expectancy". Although Reed presented no evidence to support his speculation, his view is nevertheless consistent with Carroll's (1963) theory of schooling and Bloom's (1971) mastery learning strategies.

Theory of School Learning and Mastery Learning Strategies

Most of the studies reviewed above on the relationship between IQ and reading were based upon traditional age-graded schools where tasks to be learned and time for learning them are segmented into intervals of a year. Under these conditions, degree of attainment of a given task is measured after a fixed interval of time for all learners and correlated with predictors, including IQ tests, administered at the beginning of the time interval. Consequently correlations between IQ and specific subskills involved in the processes of reading acquisition are usually based upon inadequate time for some members of the group to learn them. Even so, the relationship between IQ and these reading acquisition subskills become increasingly lower as individuals learned how to read. But, they would have been even lower had some students in the group had more time to learn them, for variability in achievement of the reading acquisition subskills within the group would then have decreased and where variability decreases on either or both variables, the correlation between them must decrease. Thus, time is a significant component in learning to read, and in relating IQ to reading.

Time to learn is stressed in the elements of Carroll's (1963) model of school learning. Three of the elements are within the learner. They are "aptitude--the amount of time needed to learn a task under optimal conditions," ability to understand instruction" which is a function of his general intelligence and verbal ability, and "perseverance--the time he is willing to engage actively in learning." The other two elements are in the following conditions of instruction: oppportunity - "time allowed for learning" - and quality of instruction. Quality of instruction is a function of the degree to which the tasks to be learned have been properly sequenced, presented, and adapted to the individual's "special needs and characteristics" and his "stage of learning." Time for learning in Carroll's model is inversely related to quality of instruction. Thus, the relationship between aptitude and achievement is a function not only of characteristics within the student but also of conditions of instruction.

Applying Carroll's model of school learning to the curriculum, Bloom (1971) pointed out that if aptitude and achievement measures are reliable and valid, the expected correlation between them is about .70 or higher where the aptitude is normally distributed in the population and the conditions of instruction are the same for all learners. But, Bloom (1971, 21-23) theorized that "the relation between aptitude and achievement should approach zero" if Carroll's model is applied to each student because about 95 percent of the population could then "learn a subject up to a high level of mastery." The five percent excluded would be those who had a special disability for learning a particular subject. For example, he refers to evidence that "selected criterion scores achieved by the top students at one grade level are achieved by the majority of students at another grade level." Also, where individuals learn at their own rates, they tend to achieve mastery at different time intervals. Bloom concluded that mastery learning is most appropriate where subjects are "required, sequential, and closed," and which emphasize convergent thinking. Such subjects, he pointed out, are important to the individual or society, require mastery type learning for cumulative progress, and can be mastered because they are characterized by a finite set of behaviors.

Mastery learning requires the use of criterion referenced tests to assess progress. Under conditions of mastery learning and criterion referenced tests, IQ for members of a particular group would probably only be related to time to master the task because at least 95 percent of the group could eventually master the task. This type of learning and assessment contrasts sharply with fixed intervals of time for learning and with norm-referenced tests, respectively. If students' achievement measured when they are the middle stages of learning closed-objective tasks, then the relationship of achievement with IQ would be higher than when the tasks were mastered by the group. But, even norm-referenced tests for closed objectives, such as symbol-sound relationships, should have zero correlations with IQ, if achievement is assessed after students have been given varying amounts of time to master these closed objectives. Thus, for closed objectives, regardless of type of assessment, but provided students are given sufficient time to achieve the objective, IQ for members of a group, ~~IQ~~ should eventually be related only to rate of acquisition.

Reading acquisition behavior appears to be susceptible to mastery learning strategies and to criterion-referenced testing. Under this type of learning, the correlation between IQ and learning to read should change from some initially high level to zero for students throughout the range of normal intelligence. The literature on IQ and reading, reviewed above, provides some indirect evidence to support this view, but more direct evidence is needed.

The closest schools have come to the ideal of providing for individual differences in rate of reading acquisition behavior is through programmed instruction. Ellson (Ellson et al., 1965) reported that the reading achievement of first grade children, given two daily 15 minute sessions of programmed tutoring, was significantly better than the control group which did not have the supplemental instruction. More significantly, the slow learners benefited most; they almost equalled the range in achievement for the average students in the control group. In a subsequent study, the findings were similar (Ellson et al., 1968). Programmed tutoring only when given twice daily produced significant improvement in reading achievement. Although children throughout the ability range improved, the gains were greatest for the low achievers. Moreover, Peabody Picture Vocabulary Test scores, which can be used as an estimate of intellectual ability, had a predictive coefficient of only .11 with the sight word recognition test and .24 with word analysis, but .52 with comprehension. Thus, it appears that supplementing classroom instruction with programmed tutoring which provides a ratio of one teaching aide to one student, careful directions, systematic sequencing of stimuli, step-by-step assessment, individually determined rate of progress, and variable time for learning is a defensible model for a mastery strategy in school learning and for further reduction in the relationship between IQ and learning to read.

Why Teachers Believe IQ is Related to Learning to Read

If IQ and reading acquisition behavior for members of a group tends to have a decreasing relationship and could have even a lower relationship as students progress through the grades, why do teachers tend to believe that the relationship is higher? Some reasons can be generated from Carroll's model of school learning, from Bloom's concept of mastery learning strategies for the curriculum, and from ways in which IQ and reading behavior are defined and assessed. An additional reason could also be based on the "conventional wisdom" of maturational determinism for reading achievement that has prevailed over the past 30 to 40 years (Durkin, 1968). This maturational determinism was supported by Morphett and Washburne (1931) who adopted the maturationist position to explain their Winnetka results, and their study has had a widespread impact on teachers' instructional belief system (Singer, 1970).

Despite conditions in the Winnetka school district, which ironically had a reading curriculum of 21 graded steps that today might be defined as a mastery type curriculum, Morphett and Washburne did not emphasize the variation in time children needed in learning to read. Instead, they computed that mental age correlated .50 with reading progress and observed that children who had attained a mental age of 6 years, 6 months prior to beginning reading made more satisfactory progress than the "less mature children." That is, the successful children had progressed through 13 steps of the Winnetka graded program and had learned a minimum of 37 sight words before February of the first grade year. Generalizing their findings to all tests of intelligence, programs of instruction, and criteria for successful progress in reading, they advocated that

> ... by postponing the teaching of reading until children reach a mental age of six and a half years, teachers can greatly decrease the chances of failure and discouragement, and can correspondingly increase their efficiency." (p. 503)

Since the mental age they advocated also tended to equal the average chronological age of the group, it was only one step more to divide chronological age by mental age and then relate an IQ of 100 or more to success in learning to read in the first grade.

In contrast, Gates and Bond (1936, pp. 684-685) invoked an environmentalist explanation for their results. They found that in some New York City schools, where teachers used a textbook and supplementary material for teaching four large classes of first grade students whose median IQ was 98.6, the correlation between Stanford-Binet mental age and reading achievement at the end of the year was about .25. Those pupils who were making <u>least</u> progress in reading made "marked" improvement after three weeks of special instruction while still in first grade. From these results, Gates concluded that the optimum time for beginning reading was not a problem in maturation but in determining when the "maximum general and social returns" would accrue from learning to read at any given time. The following statement sums up his environmentalist position for reading readiness:

> ...the optimum time of beginning reading is not entirely dependent upon the nature of the child himself, but that it is in large measure determined by the nature of the reading program. We think there is no ultimate justification for assumming that materials and methods of teaching must remain forever fixed as they are, waiting upon nature to change the child through maturity until he reaches a point at which he can proceed successfully. We think, on the other hand, that techniques and materials of reading can be adjusted to teach children successfully at the time when reading is, all things considered, of optimum value to them.

Thus, Gates and Bond sum up the conditions under which IQ is and is not related to beginning reading instruction.

Summary and Conclusion

Whether IQ is or is not related to reading for members of a particular age group depends on such variables as the nature and difficulty of the task, the capabilities of the reader, the time allowed for learning, the quality of instruction, and the nature of the tests used for assessing intelligence and reading.

The nature of the reading task can be broken down into its constituent components. At least five components are predictive of individual differences in reading achievement, but two of them tend to reach maturity in the elementary grades. Syntax tends to approach complete development about age six while graphophonological and other aspects of word recognition, such as functional oculomotor efficiency, tend to reach a mastery level about ages 12 to 14. The other components of reading achievement, such as morphological, word--meaning, and reasoning-in-reading processes, continue to develop throughout a person's lifetime.

The five components can be broadly categorized as word recognition, word meaning, and reasoning-in-reading. If the word-meaning and reasoning-in-reading aspects of the reading task are kept within the mental age range of members of a group, then the relationship between IQ and reading acquisition behavior would tend to decrease towards zero as members of the group learned to read and to master the processes of word recognition in context. But if word meaning and reasoning-in-reading continually increase in difficulty on the reading test so that they constantly challenge the most apt members of a group, then IQ will be highly related to reading achievement throughout the acquisition and even throughout the skilled stages of reading development.

The remedy is clear: separate assessment of reading acquisition from development of general reading ability, which includes not only word recognition ability but also word meaning and reasoning-in-reading. Criterion referenced tests could be used to assess the former and norm-referenced tests to measure the latter.

Thus, the relationship between IQ for members in the normal intellectual range, as assessed by an individual measuring instrument, such as the Stanford-Binet, and reading will at least be minimized, if the difficulty of the task is within the capabilities of the learner, individual differences in rate are taken into account, reading acquisition instruction is organized to facilitate sequential and cumulative learning, directions are given clearly so that all students understand them, and assessment of progress is based upon criterion-referenced tests. On the other hand, if all of these variables are at the other extreme of their continua, and particularly if group tests of intelligence and norm-referenced tests of reading achievement are used, then the relationship between intelligence and reading achievement for members of a group will be maximized.

Thus, variations in the nature of the reading task, stage of reading development, conditions of instruction, and methods of assessment determine whether IQ for members of a group is or is not related to reading.

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